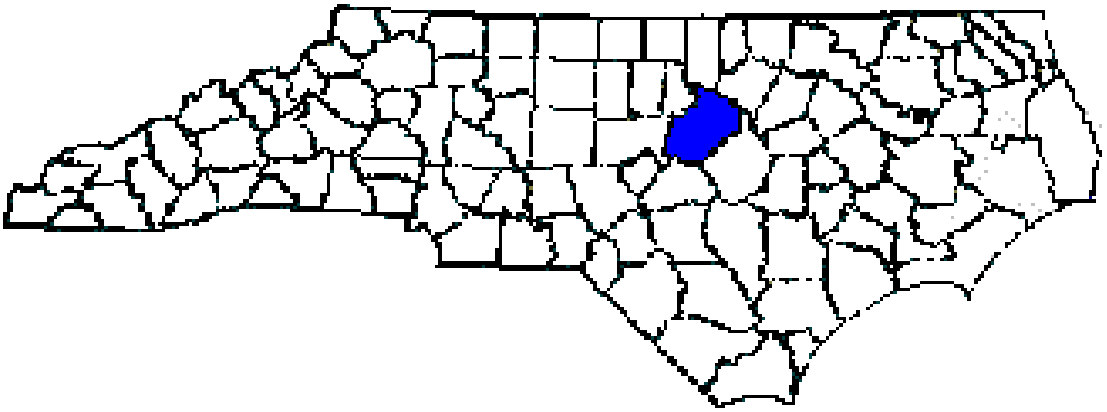
ANNUAL REPORT FOR 2007



Marks Creek Mitigation Site
Wake County
TIP No. R-2547 WM

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TABLE OF CONTENTS

FIGURES

TABLES

CHARTS

APPENDICES

SUMMARY

The following report summarizes the stream monitoring activities conducted during the Year 2007 at the Marks Creek Mitigation Site in Wake County. The site was designed and constructed during 2002 by the North Carolina Department of Transportation (NCDOT) in order to provide mitigation for stream impacts associated with the construction of T.I.P R-2547. This report provides the monitoring results for the fourth formal year of monitoring (Year 2007).

An on-site agency meeting was held in April 2006 to review the stability of the stream restoration. Six days prior to the onsite meeting, a severe storm occurred damaging a transformer at a Progress Energy Substation upstream of the mitigation site. Approx. 16,000 gallons of mineral oil was spilled into the UT to Marks Creek. Cleanup activities occurred for several weeks after the spill and at this time the site continues to recover with much of the affected vegetation returning. A detailed explanation of the storm damage and cleanup activities can be found in Appendix B.

Based on the overall monitoring assessment, the Marks Creek Site has met the required monitoring protocols for the third formal year of monitoring. All of the tributaries remain stable. There is extensive growth of vegetation throughout the stream corridor, both within and outside of the bankfull limits associated with the channel. All sixteen of the cross sections along the tributaries remain stable. Based on information obtained from the US Geological Survey (USGS), the Marks Creek Site has already met the required monitoring protocols for hydrology as it relates to bankfull events. The NCDOT will continue stream monitoring at the Marks Creek Mitigation Site for 2008.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that were conducted during the Year 2007 at the Marks Creek Site. The site is situated immediately adjacent to the right-of-way of the Knightdale Bypass in the eastern portion of Wake County (Figure 1). It is located approximately 8.0 miles east of Raleigh. The Marks Creek Site was constructed as an on-site stream mitigation project in order to provide mitigation for stream impacts associated with the construction of T.I.P. R-2547.

The stream mitigation project involved the restoration of an unnamed tributary to Marks Creek (the Main Tributary to Marks Creek) and four of its tributaries (the North, West, Southwest, and South Tributaries). As part of the project, NCDOT drained an approximately 10-acre pond and removed the dam in its entirety. In addition, new channels were constructed as near as practicable to their former locations before initial dam construction was implemented. The reconnection of the Main Tributary to Marks Creek and its tributaries to their original floodplain resulted in Priority I restoration of approximately 3,200 linear feet. Design and construction was implemented during 2002 by NCDOT. Stream restoration involved the construction of new channels and the installation of rootwads, rock vanes, rock cross vanes, log vanes to control grade and stabilize the channel. It also included the installation of native vegetation.

1.2 Purpose

In order for a mitigation site to be considered successful, the site must meet the success criteria stated in the permit conditions and approved mitigation plan. This report details the results of the stream monitoring in 2007 at the Marks Creek Mitigation Site. Vegetation and hydrologic monitoring were completed but will not be included in the stream monitoring report.

The stream monitoring in 2006 reflects the third formal year of monitoring following the restoration efforts. Included in this report are analyses of the longitudinal profile, cross sections, and pebble counts.

1.3 Project History

July to August 2001	Pond Drained
Late 2002	Restoration Completed
June 2004	Stream Channel Monitoring (Year 1)
July 2005	Stream Channel Monitoring (Year 2)
October 2006	Stream Channel Monitoring (Year 3)
November 2007	Stream Channel Monitoring (Year 4)

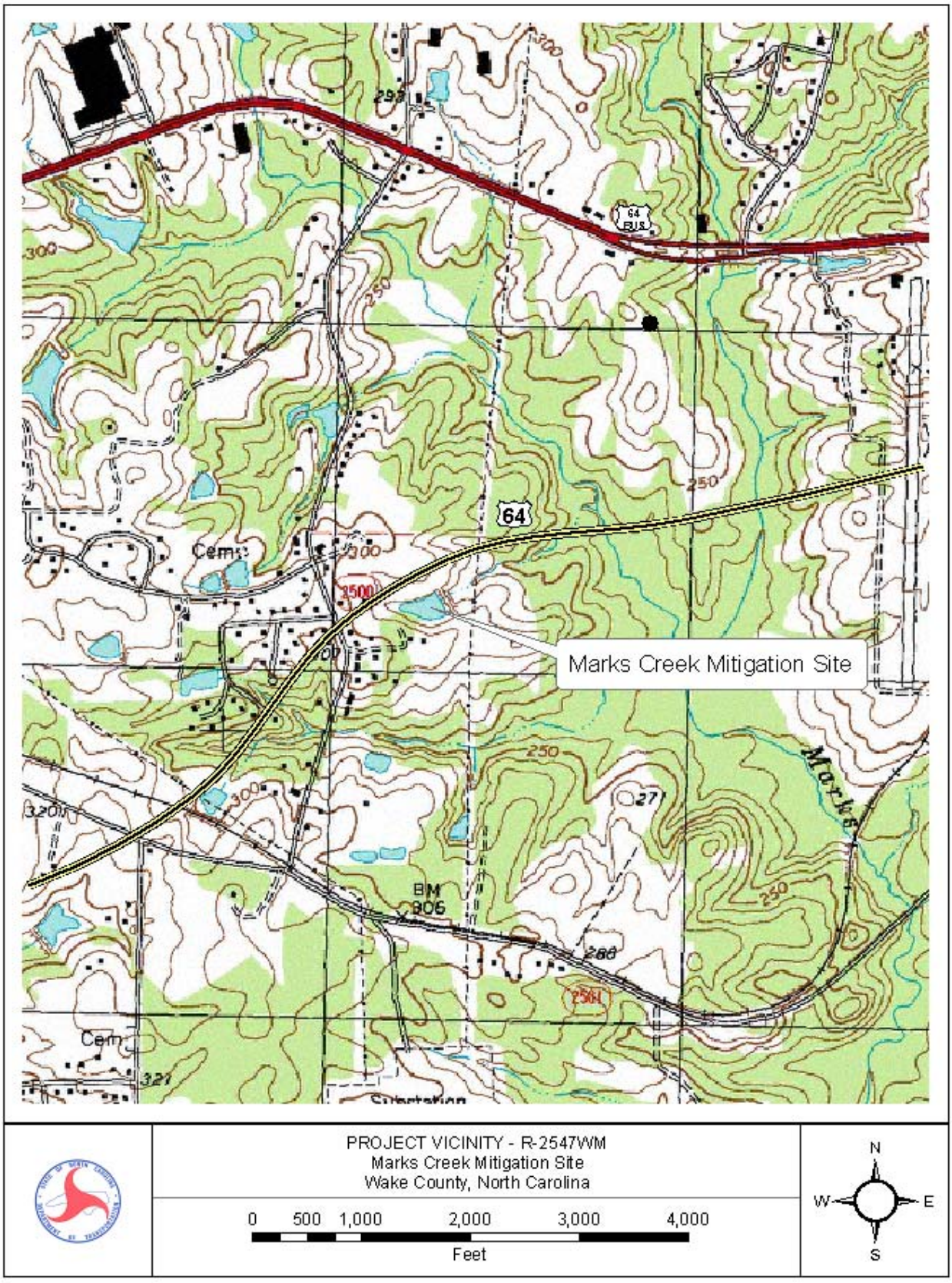


Figure 1. Site Location Map

2.0 STREAM ASSESSMENT

2.1 Success Criteria

The success criteria, as defined by federal guidelines for stream mitigation, includes the following main parameters: no less than two bankfull events for the five-year monitoring period, reference photos, plant survivability analyses, and channel stability analyses (USACE, 2003). Biological sampling was not required for this site.

Natural streams are dynamic systems that are in a constant state of change. Longitudinal profile and cross section surveys will differ from year to year based on changes in the watershed. Natural channel stability is achieved by allowing the stream to develop a proper dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades. A stable stream consistently transports its sediment load, both in size and type, associated with local deposition and scour. Channel instability occurs when the scouring process leads to degradation, or excessive sediment deposition results in aggradation (Rosgen,1996). The following surveys were conducted in support of the monitoring assessment:

- Longitudinal Profile Survey: This survey addressed the overall slope of the reach, as well as slopes between bed features. The bed features are secondary delineative criteria describing channel configuration in terms of riffle/pools, rapids, step/pools, cascades and convergence/divergence features which are inferred from channel plan form and gradient. The surveys are compared on a yearly basis to note and/or compare aggradation, degradation, head cuts, and areas of mass wasting. The longitudinal profile is expected to change from year to year. Significant changes may require additional monitoring.

- Cross Section Surveys: These surveys addressed the following characteristics at various locations along the reach: entrenchment ratio , width/depth ratio, and dominant channel materials. The entrenchment ratio is a computed index value used to describe the degree of vertical containment. The width/depth ratio is an index value which indicates the shape of the channel cross section. The dominant channel materials refer to a selected size channel material types or size categories, as determined from a channel material size distribution index.

2.2 Stream Description

2.2.1 Post-Construction Conditions

The mitigation of the tributaries to Marks Creek involved the draining of the existing pond and the construction of four new channels on site. Within the new channels, j-hook vanes, rock and log vanes, and rootwad revetments were installed. Unfortunately soon after restoration, the site was inundated with sediment from the construction of the Knightdale Bypass located upstream due to the failure of the erosion control devices.

2.2.2 Monitoring Conditions

The tributaries to Marks Creek were designed to be classified as C5 stream type channels according to the Rosgen Classification of Natural Rivers; however only the South Tributary classifies as C5, the remaining tributaries classify as a C4 stream type. A total of sixteen cross sections (four along the Main Tributary to Marks Creek and 12 along its four tributaries) were surveyed. For this report, only cross sections containing riffles were used in the comparison of channel morphology presented below in Table 1. Cross section locations are provided on Figure 2.

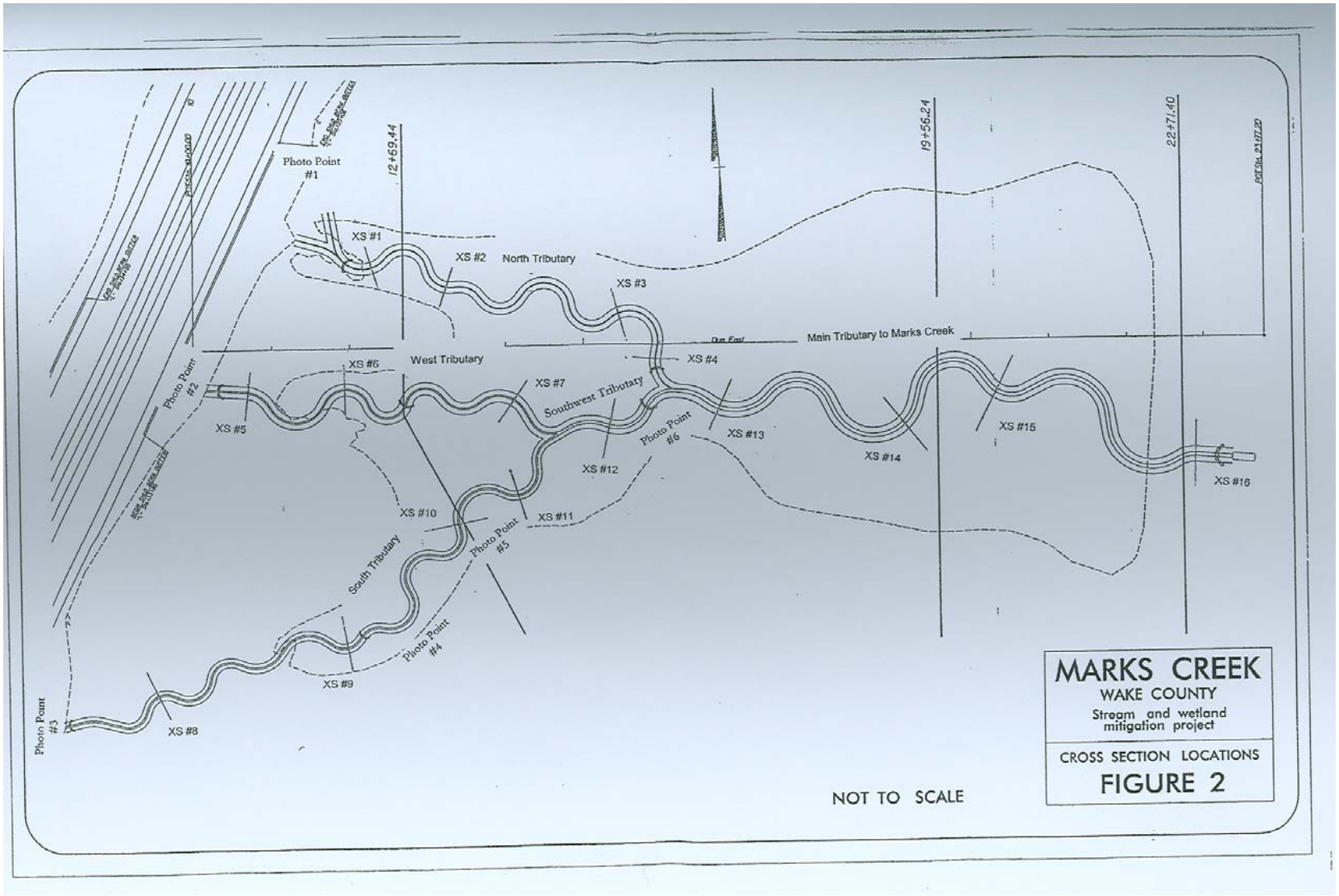


Figure 2. Cross Section Locations

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the survey of sixteen cross sections along the four tributaries. The length of the profile along the Main, North, West, South, and Southwest Tributaries were 950 linear feet, 700 linear feet, 550 linear feet, 180 linear feet, and 970 linear feet, respectively. Cross section locations are presented below. Benchmark stakes were installed on both the left and right stream banks for each cross section location. The layout comparisons of the cross sections and longitudinal profiles are shown in Appendix A.

North Tributary (Stations 0+00 through 7+00)

- Cross Section #1. North Tributary, Station 1+46, riffle section
- Cross Section #2. North Tributary, Station 2+30, riffle section
- Cross Section #3. North Tributary, Station 4+97, run section
- Cross Section #4. North Tributary, Station 6+68, pool section

West Tributary (Stations 0+00 through 5+50)

- Cross Section #5. West Tributary, Station 1+72, riffle section
- Cross Section #6. West Tributary, Station 2+89, pool section
- Cross Section #7. West Tributary, Station 4+72, riffle section

South Tributary (Stations 0+00 through 9+60)

- Cross Section #8. South Tributary, Station 1+27, run section
- Cross Section #9. South Tributary, Station 4+18, pool section
- Cross Section #10. South Tributary, Station 7+44, riffle section
- Cross Section #11. South Tributary, Station 8+59, run section

Southwest Tributary (Stations 0+00 through 1+80)

- Cross Section #12. Southwest Tributary, Station 0+72, run section

Main Tributary (Stations 0+00 through 9+70)

- Cross Section #13. Main Tributary, Station 0+78, riffle section
- Cross Section #14. Main Tributary, Station 4+60, pool section
- Cross Section #15. Main Tributary, Station 6+37, run section
- Cross Section #16. Main Tributary, Station 9+52, run section

The sixteen cross sections were established during the 2004 monitoring survey are being monitored on a yearly basis to determine the actual extent of aggradation or degradation. All of the cross section locations appeared stable when compared to the previous years monitoring data. Morphological comparisons are presented in the charts depicted below. Appendix A depicts each cross section comparison as well as a summarized table of morphological variables.

Table 1. Abbreviated Morphological Summary (Marks Creek) North Tributary (Cross Sections #1, #2, #3, and #4)								
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #1 (Riffle)**	**Cross Section #2 (Riffle)**	**Cross Section #3 (Run)**	**Cross Section #4 (Pool)**	**Min. - Max Values (Riffle Sections Only)**	
			2007	**2007**	**2007**	**2007**	**2006**	**2007**
Drainage Area (sq. mi)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Bankfull Width (ft)	15.0	13.0	13.9	15.12	6.08	18.08	13.7-15.4	13.9-15.12
Bankfull Mean Depth (ft)	1.0	0.8	0.84	0.34	0.36	1.41	0.4-0.8	0.34-0.84
Width/Depth Ratio	15.0	17.0	16.55	44.47	16.89	12.82	17.1-41.7	16.55-44.47
Bankfull Cross Sectional Area (ft^2)	8.0	10.0	11.63	5.1	2.18	25.57	5.7-11.0	5.1-11.63
Maximum Bankfull Depth (ft)	1.85	1.4	1.51	0.74	0.74	3.09	0.9-1.6	0.74-1.51
Floodprone Area (ft)	50.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.33	3.8	2.5	2.48	4.06	1.96	6.5-7.3	2.48-2.5

Table 2. Abbreviated Morphological Summary (Marks Creek) West Tributary (Cross Sections #5, #6, and #7)							
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #5 (Riffle)**	**Cross Section #6 (Pool)**	**Cross Section #7 (Riffle)**	**Min. - Max Values (Riffle Sections Only)**	
			2007	**2007**	**2007**	**2006**	**2007**
Drainage Area (sq. mi)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Bankfull Width (ft)	16.0	13.0	14.58	17.43	6.27	6.3-14.1	6.27-14.58
Bankfull Mean Depth (ft)	1.1	0.8	0.79	1.72	0.71	0.5-0.6	0.71-0.79
Width/Depth Ratio	15.0	16.0	18.46	10.13	8.83	11.7-22.4	8.83-18.46
Bankfull Cross Sectional Area (ft^2)	16.8	10.5	11.5	29.93	4.46	3.4-8.9	4.46-11.5
Maximum Bankfull Depth (ft)	1.9	1.5	1.34	3.97	1.64	1.1-1.5	1.34-1.64
Floodprone Area (ft)	50.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.13	3.8	2.55	1.81	5.94	7.1-15.9	2.55-5.94

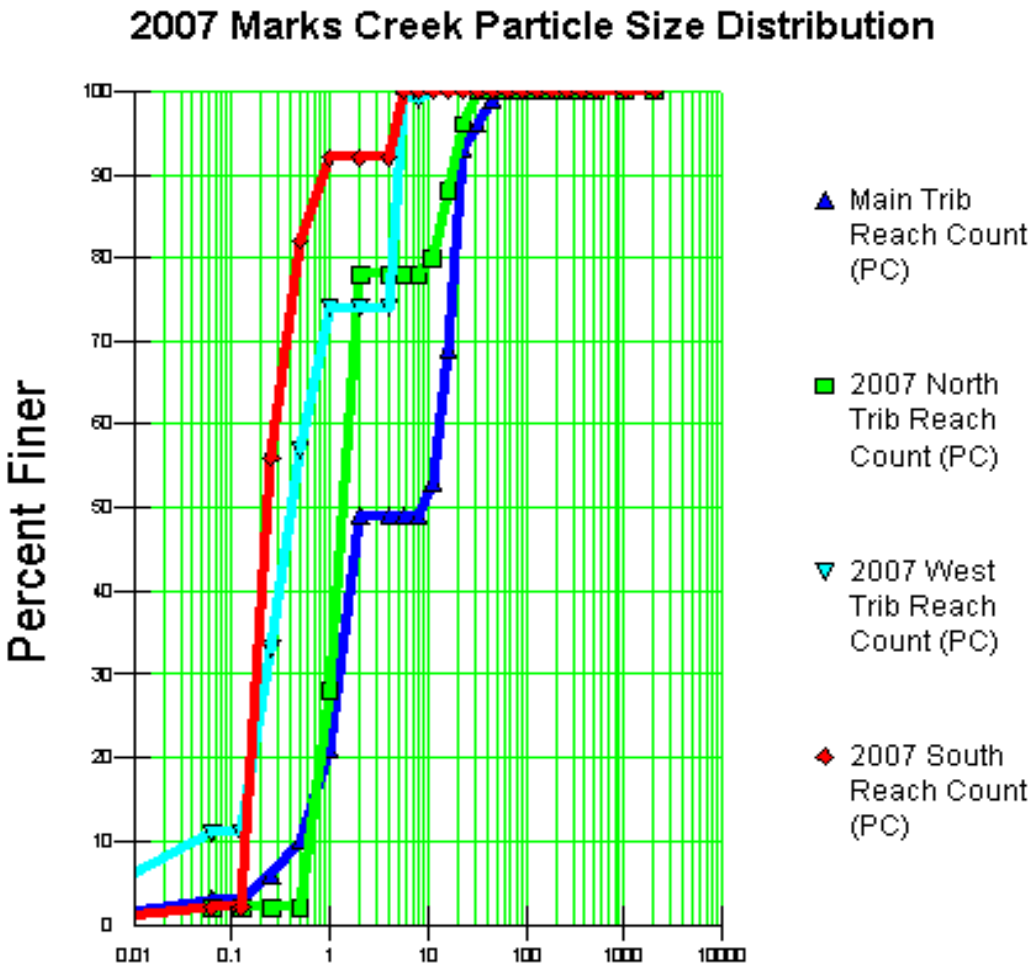
Table 3. Abbreviated Morphological Summary (Marks Creek) South Tributary (Cross Sections #8, #9, #10, and #11)								
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #8 (Run)**	**Cross Section #9 (Pool)**	**Cross Section #10 (Riffle)**	**Cross Section #11 (Run)**	**Min. - Max Values (Riffle Sections Only)**	
			2007	**2007**	**2007**	**2007**	**2006**	**2007**
Drainage Area (sq. mi)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Bankfull Width (ft)	12.0	13.0	15.17	11.20	17.61	12.76	21.0	17.61
Bankfull Mean Depth (ft)	0.8	0.7	0.41	1.19	0.30	0.22	0.2	0.30
Width/Depth Ratio	15.0	18.0	37	9.41	58.7	58	161.8	58.7
Bankfull Cross Sectional Area (ft^2)	9.9	9.0	6.27	13.35	5.31	2.85	2.8	5.31
Maximum Bankfull Depth (ft)	1.4	1.3	0.65	2.35	0.87	0.65	0.4	0.87
Floodprone Area (ft)	50.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	4.17	3.8	2.06	2.75	2.36	2.86	4.8	2.36

Table 4. Abbreviated Morphological Summary (Marks Creek) Southwest and Main Tributaries (Cross Sections #12, #13, #14, #15 and #16)									
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #12 (Run)**	**Cross Section #13 (Riffle)**	**Cross Section #14 (Pool)**	**Cross Section #15 (Run)**	**Cross Section #16 (Run)**	**Min. - Max Values (Riffle Sections Only)**	
			2007	**2007**	**2007**	**2007**	**2007**	**2006**	**2007**
Drainage Area (sq. mi)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Bankfull Width (ft)	20.0	13.0	12.37	22.92	11.5	12.34	15.64	16.7	32.7
Bankfull Mean Depth (ft)	1.4	0.7	0.36	0.79	1.01	0.65	0.90	0.6	0.5
Width/Depth Ratio	14.0	18.0	34.36	29.01	11.39	18.98	17.38	>15.0	61.7
Bankfull Cross Sectional Area (ft^2)	31.3	9.0	4.51	18.17	11.56	7.96	14.07	10.7	17.3
Maximum Bankfull Depth (ft)	2.5	1.3	0.92	1.61	1.63	1.25	1.58	1.0	1.4
Floodprone Area (ft)	60.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.0	3.8	3.39	2.18	3.31	2.75	2.37	>6.0	3.1

Pebble counts were taken along each tributary as a means to determine the extent of change in bed material during the monitoring period. The pebble counts taken during the Year 2007 monitoring period classified the stream as a gravel/sand bed system.

The graph and data depicting the 2007 particle size distributions for each tributary of Marks Creek are presented below.

Chart 1. Particle Size Distribution



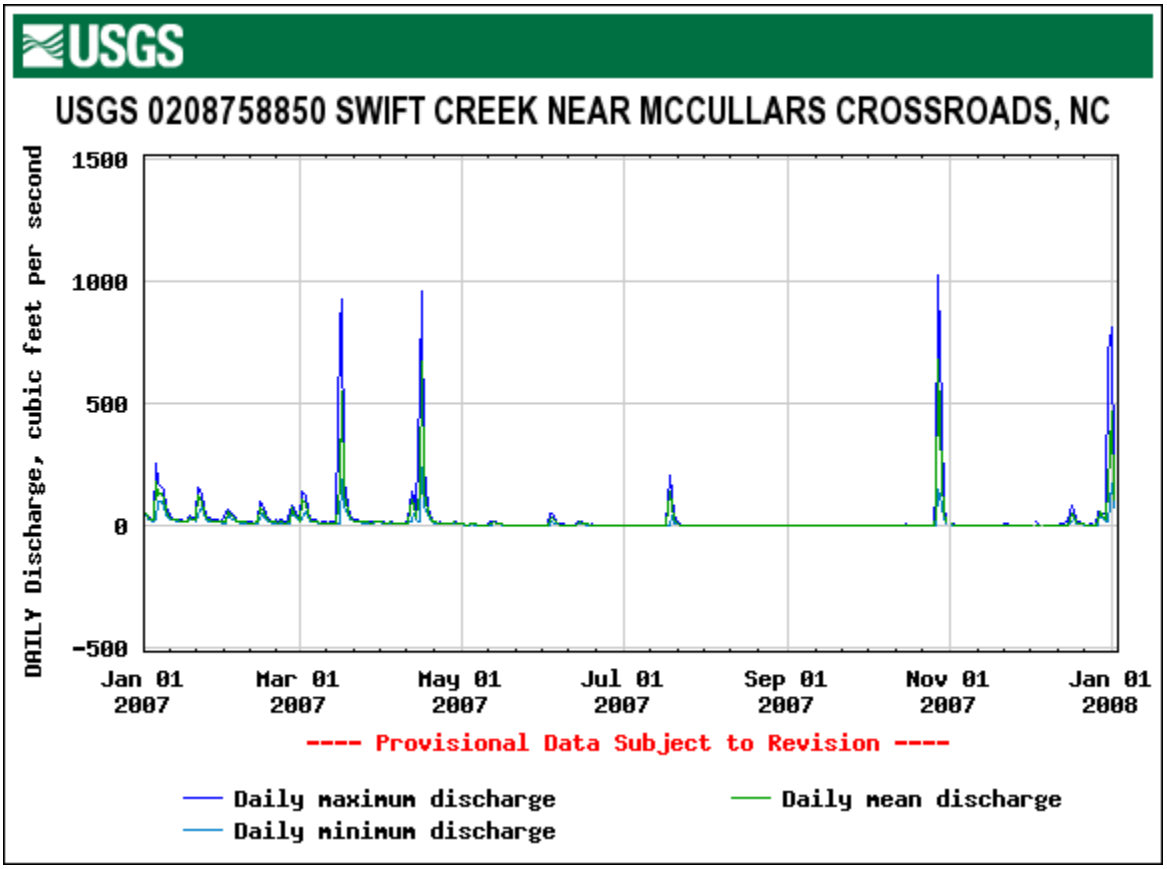
Particle Sizes	North Trib	West Trib	South Trib	Main Trib
D16 (mm)	0.77	0.15	0.16	0.77
D35 (mm)	1.14	0.27	0.2	1.5
D50 (mm)	1.44	0.43	0.24	8.83
D84 (mm)	13.65	4.68	0.6	20.13
D95 (mm)	21.78	5.43	4.64	28.87

Longitudinal profile surveys were conducted on each tributary associated with Marks Creek Mitigation Site. Bank stability was assessed during the cross section and longitudinal profile surveys. Woody and herbaceous vegetation continue to dominate the entire area associated with Marks Creek and it's tributaries.

Some localized areas of bank scouring still exist but do not warrant remedial action at this time. The South Tributary still has dense vegetation both within and outside the bankfull channel confines.

2.3.2 Climatic Data

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist along Marks Creek or its tributaries. A review of known USGS surface water gages identified one rural stream gage station within fifteen miles of the mitigation site. This gage station is identified as Swift Creek near McCullars Crossroads. The Swift Creek gage station has a drainage area of 35.8 square miles and is located approximately 15 miles southeast of the mitigation site near the confluence of Swift Creek and Lake Wheeler. The Swift Creek gage accurately reflects the hydrology and precipitation in the project area. It is situated in the USGS Hydrologic Unit 03020201. Datum of the gage is 251.46 feet above sea level NGVD29. Based on the drainage area associated with the gage, the correlated bankfull discharge according to the NC Rural Piedmont Regional Curves (USACE, 2003) is between 770 and 1,760 cubic feet per second (cfs). Following Year 2004 monitoring activities, a review of peak flows was conducted for the period between July 2002 and July 2004. According to USGS data, Marks Creek met its requirement of two bankfull events during the first year of monitoring, with both of the events happening in 2003. Reviews were also conducted for 2007. The USGS graph presented below indicates that one bankfull event occurred in 2007.



2.4 Conclusions

Based on the results obtained as part of the Year 2007 monitoring activities, the Marks Creek Site continues to function within the capacity for which it was designed. Significant problems were endured during 2003 as a result of erosion control problems associated with the construction of the US 64 Knightdale Bypass, immediately upstream from the project. All of the unnamed tributaries were inundated with sediment. NCDOT postponed the 2003 monitoring year to allow the site to stabilize. Formal monitoring was initiated in 2004. According to data collected in 2007, areas of localized bank scouring continue to exist along the tributaries but do not appear to be compromising the overall functions of the site.

Based on information obtained from the USGS, the Marks Creek Site has met the required monitoring protocols for hydrology as it relates to bankfull events that have occurred on site since the time of construction.

An on-site agency meeting was held in April 2006 to review the stability of the stream restoration. Six days prior to the onsite meeting, a severe storm occurred damaging a transformer at a Progress Energy Substation upstream of the mitigation site. Approx. 16,000 gallons of mineral oil was spilled into the UT to Marks Creek. Cleanup activities occurred for several weeks after the spill and at this time the site continues to recover with much of the affected vegetation returning. A detailed explanation of the storm damage and cleanup activities can be found in Appendix C.

Based on the data collected in 2007, the Marks Creek Site continues to improve in overall quality and function. The stream channels continue to remain stable and NCDOT will continue to monitor the site in 2008.

3.0 REFERENCES

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